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Original Contribution

The Association of Spousal Smoking Status With the Ability to Quit Smoking: The Atherosclerosis Risk in Communities Study

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Smoking is the leading cause of preventable death in the United States. Studies have shown that smoking status tends to be concordant within spouse pairs. This study aimed to estimate the association of spousal smoking status with quitting smoking in US adults. We analyzed data from 4,500 spouse pairs aged 45–64 years from the Atherosclerosis Risk in Communities Study cohort, sampled from 1986 to 1989 from 4 US communities and followed up every 3 years for a total of 9 years. Logistic regression with generalized estimating equations was used to calculate the odds ratio of quitting smoking given that one's spouse is a former smoker or a current smoker compared to a never smoker. Among men and women, being married to a current smoker decreased the odds of quitting smoking (for men, odds ratio (OR) = 0.37, 95% confidence interval (CI): 0.29, 0.46; for women, OR = 0.54, 95% CI: 0.43, 0.68). Among women only, being married to a former smoker increased the odds of quitting smoking (OR = 1.26, 95% CI: 1.04, 1.53). In conclusion, spouses of current smokers are less likely to quit, whereas women married to former smokers are more likely to quit. Smoking cessation programs and clinical advice should consider targeting couples rather than individuals.

smoking; smoking cessation; spouses

Abbreviations: ARIC, Atherosclerosis Risk in Communities; CHD, coronary heart disease; CI, confidence interval; OR, odds ratio.

Smoking is the leading cause of preventable death in the United States (1), responsible for more than 400,000 deaths per year (2). Despite widespread media attention about the negative health effects of smoking and a dramatic decrease in smoking rates in the US population over the last 50 years (3), almost 20% of American adults still smoke (1). Many smokers have difficulty quitting smoking; 69% of current smokers report that they would like to quit, and just over half report that they tried to quit and failed within the last year (4).

Evidence suggests that, in general, married couples exhibit similar health behaviors and lifestyle choices (5, 6). Further, it has been shown that changes in a wide range of behaviors in 1 spouse can promote similar changes in the other spouse (7). This concordance in behavior patterns has also been shown for smoking (5, 8). The likelihood of a person smoking is higher if his or her partner is a smoker (5). Moreover, having a partner who smokes also makes it more likely that an individual will initiate smoking (9).

Partners' smoking status also has potential implications for smoking cessation. Studies have shown that pregnant women are more likely to quit smoking if their partners do not smoke (10–12). Other studies have suggested that spousal smoking status influences smoking cessation (7, 13–16), but the majority of these findings are not generalizable to the older American population because of their focus on women during pregnancy (10–12), on the early years of marriage (13), or on populations that may not be relevant to the American context (17). Some studies were limited to interviews with only 1 spouse (14) or were retrospective in nature (15). To our knowledge, no study has examined the effect of partner smoking status on smoking behaviors or the concordance of smoking behaviors between smoking spouses. Finally,

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based on the evidence to date, it is unclear whether the association between spousal smoking status and smoking cessation is independent of other health factors or symmetrical between husbands and wives.

The aim of this study was to quantify the influence of spousal smoking status on the likelihood of quitting smoking and to determine whether the effect of spousal smoking status on quitting differs by sex in 4,500 spouse pairs over 9 years of follow-up in the Atherosclerosis Risk in Communities (ARIC) Study cohort.

METHODS

Study population

The ARIC Study is a representative, population-based cohort study initially designed to study the etiology of atherosclerosis. The ARIC Study recruited 15,792 adults aged 45–64 years from 1987 to 1989 from 4 US communities (Washington County, Maryland; Forsyth County, North Carolina; Jackson, Mississippi; and Minneapolis, Minnesota). The study protocol was approved by the institutional review boards of participating institutions. Study participants provided written informed consent. One baseline visit (visit 1) and 3 follow-up visits (visits 2, 3, and 4) were conducted 3 years apart. The ARIC Study design has been previously published (18).

The identification of spouse pairs in the ARIC Study has been previously described (6). Briefly, in each of the 4 communities, probability sampling was used to identify households. Prior to visit 1, study staff visited households to determine eligibility; all eligible adults were invited to participate in the ARIC Study. At this household enumeration, participants reported marital status (married, never married, divorced, separated, or widowed). At the household interview, participants were asked to identify their spouses. In cases where this information was not available, participants were considered spouses if exactly 2 adults lived in the same household and both reported being married. This analysis is restricted to married pairs enrolled in the ARIC Study.

Exposure, outcome, and risk factors

Smoking status was ascertained by self-report. At each visit, participants were asked if they had ever smoked and if they currently smoked. Additionally, participants reported the number of cigarettes they smoked per day (or the number they had smoked if they were former smokers), the age at which they started smoking (at visit 1 only) and the age at which they stopped smoking. Participants who reported that they had smoked in the past but did not currently smoke were classified as former smokers regardless of the date they reported quitting. On the basis of the reported duration and the average of the number of cigarettes smoked per day reported at each visit, we calculated the number of years and pack-years of smoking. These measures of smoking were ascertained at each visit.

We examined the impact of the spouse's smoking status on quitting smoking separately for men and women. For women, the exposure of interest was the smoking status of their husbands (former, current, or never). All exposure levels were mutually exclusive. The outcome of interest was quitting smoking (i.e., being a former smoker rather than a current smoker); therefore, the analysis was limited to women who reported ever smoking at baseline. Among men with a history of smoking, we conducted the complementary analysis assessing the impact of their wives' smoking status on quitting smoking.

Age, race, educational level, and alcohol intake were self-reported at baseline. Low educational level was defined as less than high school education. Additionally, hypertension status at each visit was defined as the self-reported use of medication to treat hypertension, measured systolic blood pressure greater than 140 mm Hg, or measured diastolic blood pressure greater than 90 mm Hg. Body mass index (weight (kg)/height $(m)^2$) was calculated at each visit. Coronary heart disease (CHD) at each visit was defined as self-reported CHD at baseline (visit 1) and a combination of self-reported CHD at baseline and adjudicated CHD events (myocardial infarction, silent myocardial infarction, and cardiac procedures) for subsequent visits.

Data analysis

First, we tested whether the husband and wife differed by smoking status using McNemar's test for paired data and calculated the marginal and paired frequencies. Additionally, we calculated the difference in the number of cigarettes spouses smoked per day (both at the time they last smoked and currently), the ages at which they started and stopped smoking, and the number of years and pack-years of smoking. The paired differences in these continuous variables were tested using a paired t test. Additionally, we calculated the Spearman correlation between the husbands' and wives' pack-years, number of cigarettes, and number of years smoked. All P values were 2-sided.

Next, we used longitudinal data analysis to calculate the odds ratio of quitting smoking based on spousal smoking status across all 4 visits. Analyses were limited to those who reported being current or former smokers at baseline. These marginal odds ratios were calculated separately for men and women using logistic regression with generalized estimating equations and assuming unstructured correlation (19). We tested the association using the following 4 models: 1) unadjusted; 2) adjusted for age and study center; 3) additionally adjusted for race, education, alcohol intake, income, and time-varying hypertension, body mass index, and CHD; and 4) additionally adjusted for spouse's CHD status.

The unadjusted model represents the total spousal association including shared norms, practices, and behaviors. The adjusted models are meant to account for both social and physiological traits, which may be associated with both the husband and wife quitting smoking and which may, thus, potentially confound the spousal association. By estimating the associations separately for husbands and wives, we were able to assess whether they were symmetrical, that is, whether the effect of the husband's smoking status on the wife's quitting smoking was the same as the effect of the wife's smoking status on the husband's quitting smoking. All analyses were performed using SAS, version 9.1, software (SAS Institute, Inc., Cary, North Carolina).

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Table 1. Characteristics of the Spouse Pairs and the Concordance of Smoking Status in the Atherosclerosis Risk in Communities Study, 1986–1998

Characteristic	Individual Data					Paired Data, %				
	Husbands		Wives		*P* Value	H+/W+	H+/W−	H−/W+	H−/W−	*P* Value[a]
	%	Mean (SD)	%	Mean (SD)						
Overall baseline										
White race	85		84		0.95	84	<1	<1	15	0.82
Education <12th grade	23		17		<0.001	10	12	6	71	<0.001
Household income <$50,000[b]	67		68		0.87	67	1	2	30	<0.001
Hypertension	33		29		<0.001	12	21	17	50	<0.001
History of CHD	9		2		<0.001	<1	8	2	90	<0.001
Never smoked	31		57		<0.001	21	8	34	37	<0.001
Age, years		55 (5.4)		53 (5.2)	<0.001					
Body mass index[c]		27.5 (4.1)		27.1 (5.7)	<0.001					
Alcohol intake, servings/week		4.7 (8.5)		1.5 (3.5)	<0.001					
Among pairs in which both partners are ever smokers										
Former smokers[d,e]										
Visit 1[f]	62		52		<0.001	40	22	12	26	<0.001
Visit 2[f]	67		62		<0.001	48	20	14	19	<0.001
Visit 3[f]	76		68		<0.001	57	19	11	13	<0.001
Visit 4[f]	80		75		<0.001	64	16	11	9	<0.001

Abbreviations: CHD, coronary heart disease; H+, husband has the characteristic; H−, husband does not have the characteristic; W+, wife has the characteristic; W−, wife does not have the characteristic.

[a] McNemar's exact *P* value.

[b] Men and women reported information separately.

[c] Weight (kg)/height (m)^2.

[d] Former smokers are the inverse of current smokers.

[e] Visit 1 represents baseline; follow-up visits occurred 3 years apart.

[f] At visit 1, $n = 1{,}652$; at visit 2, $n = 1{,}551$; at visit 3, $n = 1{,}308$; and at visit 4, $n = 1{,}140$.

RESULTS

Study population

Of the 4,500 spouse pairs in the ARIC cohort, we included the 4,494 pairs who participated in at least the first visit of the ARIC Study and who had available data on self-reported smoking status. Spouse pairs were included in each visit for which both attended and had data on smoking status. By visit 4, at least 1 member of 1,490 pairs (33%) had died or was lost to follow-up. Spouse pairs were likely to be the same race, with only 20 pairs reporting discordance on race. At baseline, wives were younger than their husbands (53 vs. 55 years) but had similar body mass index values (27.1 vs. 27.5). Husbands were more likely to be hypertensive (33% vs. 29%) and had a higher prevalence of CHD than their wives (9% vs. 2%) (Table 1). Husbands were also more likely not to have finished high school (23% vs. 17%) and to have a higher weekly intake of alcohol (4.7 vs. 1.5 servings).

Discordance of smoking in spouse pairs

At baseline, wives were more likely to be never smokers compared with their husbands (57% vs. 31%). Among pairs in which both husband and wife were either current smokers or had smoked in the past, husbands were more likely to have quit smoking compared with their wives at baseline (62% vs. 52%) and across all subsequent study visits (at visit 2, 67% vs. 52%; at visit 3, 76% vs. 68%; and at visit 4, 80% vs. 75%) Overall prevalence of current smoking, however, declined with each visit for both men and women (Table 1).

Overall, 21% of spouse pairs comprised never smokers, and 37% comprised current or former smokers at baseline. The remaining 42% of couples were discordant on smoking; among these couples, it was far more common for the husband to have smoked at some point (34%) compared with the wife (8%) (Table 1).

At baseline, 1,652 spouse pairs comprised only people who had ever smoked (either current or former smokers). At visits 2, 3, and 4 this dropped to 1,551, 1,308, and 1,140

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pairs, respectively. The percentage of ever-smoking couples in which both husband and wife were former smokers increased over the subsequent 3 study visits (40% at visit 1; 48% at visit 2; 57% at visit 3; and 64% at visit 4). In ever-smoking couples who were discordant on smoking, the percentage of couples in whom only the husband was a former smoker decreased between study visits (22% at visit 1 to 16% at visit 4), whereas there was little change in couples in which only the wife was a former smoker (12% at visit 1 and 11% at visit 4). The proportion of couples in which both the husband and wife were current smokers decreased sharply over the course of the study (from 26% at visit 1 to 9% at visit 4).

Influence of spousal smoking status on quitting smoking

Spousal smoking status was significantly associated with the likelihood of quitting smoking. In the logistic regression model adjusted for individual characteristics and spouse's CHD status, compared with having a never-smoking spouse, having a current smoker for a spouse was associated with lower odds of quitting both in women (odds ratio (OR) = 0.54, 95% confidence interval (CI): 0.43, 0.68) and men (OR = 0.37, 95% CI: 0.29, 0.46). Having a spouse who was a former smoker compared with a never smoker was associated with an increased likelihood of smoking cessation in women (OR = 1.26, 95% CI: 1.04, 1.53) but not in men (OR = 1.02, 95% CI: 0.85, 1.24). Results did not differ substantially between the unadjusted model, the model adjusted for risk factors that are potential confounders, and the model further adjusted for spouse's CHD history (Table 2).

Table 2. Association Between Quitting Smoking and Spousal Smoking Status in the Atherosclerosis Risk in Communities Study, 1986–1998

Model by Spousal Smoking Status	Wife Quitting (n = 1,875)		Husband Quitting (n = 2,980)	
	OR	95% CI	OR	95% CI
Spouse current smoker[a]				
Unadjusted	0.50	0.42, 0.61	0.38	0.33, 0.44
Age- and study center–adjusted	0.51	0.42, 0.62	0.35	0.29, 0.43
Multivariable adjusted[b]	0.55	0.44, 0.69	0.37	0.30, 0.46
Adjusted for spouse's CHD status[c]	0.54	0.43, 0.68	0.37	0.29, 0.46
Spouse former smoker[a]				
Unadjusted	1.23	1.05, 1.45	0.96	0.85, 1.08
Age- and study center–adjusted	1.23	1.04, 1.45	1.02	0.86, 1.19
Multivariable adjusted[b]	1.26	1.04, 1.53	1.03	0.85, 1.24
Adjusted for spouse's CHD status[c]	1.26	1.04, 1.53	1.02	0.85, 1.24

Abbreviations: CHD, coronary heart disease; CI, confidence interval; OR, odds ratio.

[a] The comparison group is subjects whose spouses never smoked.

[b] Risk factors are age, race, education, alcohol use, income, center, time-varying hypertension, body mass index (weight (kg)/height (m)^2), and CHD.

[c] Further adjusted for spouse's time-varying CHD history .

Smoking behaviors

In an analysis restricted to only those spouse pairs in which both members reported a history of smoking, husbands were more likely to have started smoking at an earlier age, to have quit smoking at a later age, and to have smoked more cigarettes than their wives. Modest correlations between husbands and wives were observed for the number of cigarette pack-years (r = 0.28), the number of cigarettes smoked (r = 0.23), and the number of years smoked (r = 0.29) (Table 3).

Among men who were current smokers, the mean number of cigarettes smoked per day across all visits was significantly lower among those whose wives were never or former smokers compared with those whose wives were current smokers. Although a similar pattern was observed for female current smokers, it was less consistent (Table 4). Regardless of spousal smoking status, the number of cigarettes smoked per day decreased across visits.

DISCUSSION

This study suggests that spousal smoking status influences one's own propensity to quit smoking. Compared with subjects whose spouses had never smoked, subjects whose spouses were current smokers had significantly lower chances of quitting. This was true for both men and women and remained unchanged after controlling for physiological or social factors that may influence smoking status. This effect was not symmetrical between sexes; having a spouse who smoked had a stronger adverse impact on men's ability to quit than on women's. Further, women who were current smokers and married to former smokers were more likely to quit themselves compared with women who were married to never smokers. The association was specific to women; men who were current smokers and whose spouses were former smokers had the same odds of quitting smoking as men married to never smokers. Finally, spousal smoking status was also associated with one's own smoking behavior, particularly in men; smokers married to former or never smokers were likely to smoke fewer cigarettes per day compared with those married to current smokers.

The inconsistency of associations between men and women was also evident when examining discordant pairs. Overall, more spouses were concordant on smoking status than not. When spouses were discordant, husbands were more likely to have ever smoked compared with their wives, reflecting the higher smoking rates among men than women in the general population (3). At the same time, however, among couples in which both spouses reported a history of smoking, wives were more likely to continue to smoke, and this was true across all visits.

Overall, our results confirm findings from previous studies (4, 7–10, 18). Although a few studies have reported nonsignificant results (13, 14, 17), most have shown a significant association between spousal smoking status and the likelihood of smoking cessation (7, 10–12, 15, 16). Of the 3 studies from the general population that reported spousal smoking status as having a significant effect on the likelihood of

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Table 3. Smoking Characteristics of Spouses Enrolled in the Atherosclerosis Risk in Communities Study, 1986–1998[a]

Baseline Characteristic	Correlation Between Spouses	Individual Data		Paired Data	
		Mean (SD) for Husbands	Mean (SD) for Wives	Mean Difference (SD)[b]	*P* Value[c]
Age started smoking, years[d,e]	0.10	17.5 (3.9)	19.8 (5.5)	−2.3 (6.4)	<0.001
Age stopped smoking, years[f]	0.42	42.1 (10.5)	39.5 (11.1)	2.6 (11.6)	<0.001
No. of years smoked[d]	0.29	29.5 (11.7)	26.2 (11.4)	3.4 (13.9)	<0.001
No. of cigarettes per day[d]	0.23	23.3 (12.0)	16.5 (9.9)	6.8 (13.8)	<0.001
No. of pack-years[d]	0.28	35.4 (23.9)	23.4 (17.7)	12.0 (25.1)	<0.001

Abbreviation: SD, standard deviation.
[a] Sample sizes vary because these analyses were limited to spouse pairs in which both individuals reported these characteristics.
[b] Mean difference between husbands and wives.
[c] *P* values based on paired *t* test.
[d] Among pairs in which both spouses were either former or current smokers.
[e] To account for improbable values, we set the lowest age at which a subject could have started smoking to 7 years.
[f] Among pairs in which both members were former smokers.

smoking cessation, 1 compared smoking spouses versus nonsmoking spouses only (16). Two others distinguished between spouses who were current versus former smokers, but the results varied. Our results are similar to those of a Dutch study, which showed that people married to former smokers were twice as likely to quit smoking as those married to never smokers (OR = 2.02, 95% CI: 1.38, 2.97), and that those married to current smokers were just over half as likely to quit (OR = 0.59, 95% CI: 0.43, 0.82) (15). In a survey of approximately 6,000 Americans of similar ages to the those in the ARIC cohort, having a partner who quit smoking during follow-up was associated with 7–8 times higher odds of quitting (although the variability around the estimates was very wide) compared with having a partner who was a current smoker (for women, OR = 8.52, 95% CI: 3.39, 21.4; for men, OR = 7.53, 95% CI: 3.46, 16.36) (7). However, in contrast to our findings, there was no evidence from that study that being married to a never smoker (compared with a current smoker) was advantageous for quitting among women (OR = 1.79, 95% CI: 0.73, 4.38).

Table 4. Number of Cigarettes Currently Smoked by Spouse's Baseline Smoking Status in the Atherosclerosis Risk in Communities Study, 1986–1998

Smoking Status	No. of Cigarettes Smoked, mean (SD)			
	Visit 1	Visit 2	Visit 3	Visit 4
Wife				
Current	26.5 (13.4)	24.1 (13.5)	22.3 (12.0)	22.5 (12.5)
Former	22.0 (12.4)[a]	19.7 (11.2)[a]	19.2 (10.4)[b]	18.3 (10.8)[b]
Never	21.8 (12.8)[a]	19.8 (12.1)[a]	17.6 (11.0)[a]	16.8 (10.0)[a]
Husband				
Current	20.8 (11.7)	17.8 (10.7)	16.8 (10.1)	16.3 (11.4)
Former	18.5 (10.7)[b]	16.8 (9.3)	15.5 (9.4)	15.5 (9.0)
Never	16.3 (11.2)[a]	14.5 (9.6)[b]	13.8 (9.2)[b]	14.4 (9.4)

Abbreviation: SD, standard deviation.
[a] $P < 0.001$ compared with current.
[b] $P < 0.05$ compared with current.

Our study provides the first evidence that men and women may differ in terms of how they are influenced by their spouses' smoking status. To our knowledge, the only 2 studies to examine this question found no evidence of a difference by sex (7, 16). However, Homish and Leonard (13) did find different patterns of influence on smoking relapse according to whether the husband or wife smoked; upon marriage to current smokers, women (but not men) were more likely to resume smoking compared with those married to nonsmokers.

This study has several strengths. The ARIC cohort includes a large number of spouse pairs (4,500), of which a significant portion (1,652) contained only current or former smokers. Further, its prospective design incorporates 9 years of follow-up, allowing us to observe a large number of participants who quit smoking. In addition to simply recording smoking status, we were also able to measure the number of cigarettes smoked per day, as well as the duration and pack-years of smoking.

This study also has some limitations. First, the definition of marriage was limited to heterosexual partners who were legally married to each other and, therefore, may not be applicable to couples cohabiting but not married or to same-sex couples. Second, marital status was assessed only at baseline and, therefore, some of the included couples may not have been married at later visits. This, however, is less likely given the older age of the ARIC participants and the relative stability of marriage at this age (20). Third, smoking status was assessed by self-report and potentially subject to social desirability bias. Fourth, we were not able to take into account the effects of smoking cessation medication, health care provider advice, or participation in smoking cessation programs. Finally, some of the changes seen in smoking behaviors over time may be caused by a survivor effect and may not be generalizable to the overall population; current smokers or those who smoked more cigarettes may have died during follow-up.

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To support continued decreases in adult smoking prevalence, new and innovative approaches are needed. The findings of this study may have important implications for smoking cessation programs. Not only do smokers have a higher likelihood of being married to other smokers (5), but our findings suggest that both men and women married to current smokers are the least likely to quit smoking. Targeting the married couple rather than the individual in public health campaigns, smoking cessation programs, and physician counseling may be critical. Further, having a spouse who is a former smoker rather than a never smoker is associated with a greater chance of quitting, but only in women. We hypothesize that this may be caused by the fact that women are more likely to engage in health-seeking behavior (7) and, thus, are more receptive to quitting smoking if their husbands do. However, the reasons for the differences by sex warrant further investigation and could help inform future smoking cessation programs specifically targeting married couples.

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